

The Effect of Apple Cider Vinegar and Grape Vinegar on Lipid Profile in Albino White Rats

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ABSTRACT

This study was designed to determine and compare the effect of apple and grape vinegars on lipid profile in male Albino White rats. Fifty male albino white rats (Wt.200-300 gram) divided into five groups with 10 rats in each group. The control group (G1) was fed standard animal food. Group 2 (G2) and group 3 (G3) were fed apple cider vinegar in their food for 4 weeks (3%, 6%, respectively), while group 4 (G4) and group 5 (G5) were fed grape vinegar in their food for 4 weeks (3%, 6%, respectively). Blood samples were collected at the start and at the end of the experiment to assess total cholesterol (TC), triglyceride (TG), high density lipoprotein cholesterol (HDL-c) and low density lipoprotein cholesterol (LDL-c). Results showed significant reduction in TC, TG, and LDL-c, associated with significant elevation in HDL-c after 4 weeks of vinegar feeding. The significant changes seen upon vinegar feeding on lipid profile were directly correlated with the concentration used. In conclusion, vinegars would have beneficial effect in cardiovascular disease reduction.

Keywords: Apple cider vinegar; Grape vinegar; lipid profile; Albino white rats.

1. INTRODUCTION

Vinegar is derived from Vin aigre which mean "sour wine" that is made from any fermentation of carbohydrate sources as apple, grape, melon, honey and potatoes, where yeast ferments sugar to alcohol, the latter is converted to acetic acid by Acetobacter bacteria. Acetic acid is a volatile organic acid that is responsible for the trot flavor and biting odor of vinegar⁽¹⁾. Food additives, being of natural origin, hold several advantages over conventional drugs that may earn them a more prominent place in the medicine of the future⁽²⁾. Vinegar which is used commonly as a condiment in food was proven to have some therapeutically uses contributed by the acetic acid which is the main component of vinegar. Other

constituents of vinegar include, anthocyanins (e.g. Cyanidin-3-glucoside) flavonols (e.g. quercetin, kaempferol), flavanols (Catechin, epicatechin)⁽³⁾, vitamins, mineral salts, amino acids and nonvolatile organic acids (eg. tartaric, citric, malic, lactic)⁽⁴⁾. Vinegar also contains polyphenolic compounds (eg. garlic acid, lactic acid). All these constituents contribute in a way or another to the therapeutic activity of vinegar.

Vinegar causes reduction in serum total cholesterol and triglyceride allowing improvement of lipid profile and reduces cardiovascular diseases risks⁽⁵⁾. Vinegar also have multiple effects as decreasing blood pressure⁽⁶⁾, enhancement of glycogen repletion⁽⁷⁾, increasing ability of the body to absorb excess amounts of calcium which contribute to protection from bone disease⁽⁸⁾. Recent studies have showed that vinegar ingestion decreases the glucose response to a carbohydrate load in normal and diabetic subjects^(9, 10). This study focused on the effect of apple cider vinegar and grape vinegar on lipid profile

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levels in male albino white rats, and sought to determine the more effective vinegar type.

2. Subjects, Materials and Methods

2.1. Study design

This study is an experimental study, focusing on the effect of apple and grape vinegars on lipid profile in male Albino White rats.

2.2. Animals

Fifty male Albino white rats 8-10 weeks of age and weighting 200-300grams were purchased from Egypt and placed for two weeks adaptation period before starting the experiment. Rats were maintained on 12hrs light-dark cycle and fasted 12-18hrs. before the experimental protocol started.

2.3. Materials

- Apple cider vinegar (acetic acid concentration 3.8%) and Grape vinegar (acetic acid concentration 4.2%) were purchased from local company (El-Maslamany company-Gaza), and tested at Al-Azhar university laboratories (6/2012).
- Male Albino White rats purchased from Egypt.
- High density lipoprotein, Cholesterol, Triglyceride laboratory kits (Daysis type), were purchased from local company (Murtaja Medical Corporation- Gaza).

2.4. Experimental protocol

Fifty male albino white rats were divided into five groups as the following:

- **Group 1 (G1):** It is a control group and consists of 10 male albino white rats (n=10). It was fed standard animal food.
- **Group 2 (G2):** It was fed animal food mixed with apple cider vinegar (3g vinegar/100g animal food) for 4 weeks and it consists of 10 male albino white rats (n=10).
- **Group 3 (G3):** It was fed animal food mixed with apple cider vinegar (6g vinegar/100g animal food) for 4 weeks and it consists of 10 male albino white rats (n=10).

- **Group 4 (G4):** It was fed animal food mixed with grape vinegar (3g vinegar/100g animal food) for 4 weeks and it consists of 10 male albino white rats (n=10).
- **Group 5 (G5):** It was fed animal food mixed with grape vinegar (6gr. vinegar/100gr. animal food) for 4 weeks and it consists of 10 male albino white rats (n=10).

Rats were fasted for (12-18) hours with free water access before blood sample (0.5-1.0 ml) was withdrawn from rat tails. Plasma was separated by centrifugation at 2500 x at 20 c° for 10 minutes and then tested for lipid profile. Blood samples were taken at the start of the experimental protocol and after 4 weeks of vinegar feeding. Biochemical tests were carried out in Al-Azhar university laboratories to assess the total cholesterol (TC), triglyceride (TG), high density lipoprotein cholesterol (HDL-c) levels experimentally, while the low density lipoprotein cholesterol (LDL-c) level was calculated by using Friedwald equation.

2.5. Ethical considerations

The study did not deal with humans. Animals used in the study were treated with anesthesia (thiopental 1ml/kg) before blood withdrawal and then were followed up to ensure complete recovery.

2.6. Data analysis

Data was analyzed using the statistical package of social science (SPSS) program version 18, Microsoft Excel program. Changes in measured parameters after commencement of vinegar ingestion were compared with the values before ingestion by using the paired t-test. The results are presented as means. (P value < 0.05 was considered statistically significant).

3. Results

The obtained results of our study showed that apple vinegar feeding to male Albino White rats for 4 weeks caused more effective reductions in various types of plasma lipids when compared with grape vinegar feeding,

indicating that it would have more beneficial effect in reducing cardiovascular disease risks.

3.1. Control group lipid profile

Lipid profile (TC, TG, HDL and LDL) of the control group following 4 weeks of feeding normal animal food showed minor alteration that were non-significant when compared with pre-experimental values. TC increased slightly from 79.68 to 79.91 mg/dl, similar minor alteration occurred to the TG level, where it increased from 33.73 to 33.99 mg/dl. High density lipoprotein level also showed small non-significant increases from 30.57 to 31.54 mg/dl. On other hand, LDL level showed slight reduction from 42.12 to 42.09 mg/dl, which was also non-significant statistically. The changes of lipid profile levels seen in the control group suggest that, rats were not exposed to unstable conditions that could hamper the use of these values for comparison with other treated groups.

3.2. Effect of apple vinegar feeding on lipid profile in male albino white rats.

Feeding different groups of rats apple vinegar (3%, 6%) for 4-weeks caused significant reductions in TG, TC and LDL levels, and significant increases in HDL levels at the same time. For example, after 4 weeks of apple vinegar feeding, the total cholesterol level decreased from 74.26 to 72.11 mg/dl and from 75.24 to 68.03 mg/dl in

G2 and G3, respectively (Table 1). Moreover, the results in table 1 show a significant reduction in triglyceride level (from 30.26 mg/dl to 26.34 mg/dl and from 31.12 mg/dl to 26.34 mg/dl in G2 and G3 respectively). The LDL-c level also reduced from 37.97 mg/dl to 33.47 mg/dl and from 39.17 mg/dl to 22.59 mg/dl in G2 and G3 respectively. Regarding HDL-c level, it increased from 30.29 mg/dl to 33.06 mg/dl and from 29.80 mg/dl to 40.72 mg/dl in G2 and G3, respectively.

3.3. Effect of grape vinegar feeding on lipid profile in male albino white rats.

The results in table 2 showed that the grape vinegar feeding (3%, 6%) caused significant reduction in TC, TG, and LDL. At the same time HDL-c level increased significantly. To illustrate, the cholesterol level was reduced from 82.96 to 81.26 mg/dl and from 74.90 mg/dl to 69.35 mg/dl in G4 and G5 respectively (Table 2). Furthermore, the triglyceride level was reduced from 34.94 mg/dl to 32.64 mg/dl and from 31.24 mg/dl to 27.30 mg/dl in G4 and G5, respectively. Similarly, the LDL-c level was also reduced from 43.77mg/dl to 40.56 mg/dl and from 38.75 to 27.23 mg/dl in G4 and G5 respectively. In contrast, a significant increase in HDL-c level seen from 32.22 mg/dl to 34.16 mg/dl and from 29.96 mg/dl to 36.56 mg/dl in G4 and G5 respectively.

Table 1. Lipid profile changes in Apple vinegar treated groups

variable	Apple vinegar 3%(G2)			Apple vinegar 6%(G3)		
	Before	After	P. value	Before	After	P. value
Mean TC (mg/dl)	74.26	72.11	0.00**	75.24	68.03	0.00**
Mean TG (mg/dl)	30.26	27.3	0.00**	31.12	26.34	0.00**
Mean LDL-c (mg/dl)	37.79	33.47	0.00**	39.17	22.59	0.00**
Mean HDL-c (mg/dl)	30.29	33.06	0.00**	29.80	40.72	0.00**

** significance (P<0.05)

TC: Total Cholesterol, TG: Triglyceride, HDL: High Density lipoprotein, LDL: low Density Lipoprotein.

Table 2. Lipid Profile Changes in Grape Vinegar Groups

Variable	Grape vinegar (G4) 3%			Grape vinegar (G5)6%		
	Before	After	P. value	Before	After	P. value
Mean TC (mg/dl)	82.96	81.26	0.00**	74.90	69.35	0.00**
Mean TG (mg/dl)	34.94	32.64	0.00**	31.24	27.30	0.00**
Mean LDL-c (mg/dl)	43.77	40.56	0.00**	38.75	27.23	0.00**
Mean HDL-c (mg/dl)	32.22	34.16	0.00**	29.96	36.56	0.00**

** significance (P<0.05)

TC: Total Cholesterol, TG: Triglyceride, HDL: High Density lipoprotein, LDL: low Density Lipoprotein.

3.4. Comparison of the apple and grape vinegar (3%, 6%) feeding effect on lipid profile.

Comparing the effect of apple and grape vinegar feeding (3%, 6%) to male albino white rats on TC, TG, LDL-c and HDL-c showed that:

- The highest reduction in cholesterol, triglyceride, LDL-cholesterol level was caused by apple 6% feeding for 4 weeks, and the lowest effect was produced by grape vinegar 3% feeding (Table 3).

- The highest improvement in HDL-cholesterol level was seen with the apple 6% vinegar feeding (Table 3).

When compared other groups with the 6% apple vinegar fed group (G3) it was followed by the 6% grape vinegar fed group (G5), while the apple 3% fed group (G2) showed significant but weak improvement in lipid profile. The least effect on lipid levels was seen with the grape vinegar 3% fed group (G4) as shown in figure 1.

Table 3. shows lipid levels changes (%) in different groups of rats following 4 weeks of experimental protocol

Variable	TC	TG	HDL-c	LDL-c
Group 1 (G1)	↓↓ 0.3%	↓↓ 1%	↑↑ 0.6%	↓↓ 2%
Group 2 (G2)	↓↓ 3% *	↓↓ 10% *	↑↑ 9% *	↓↓ 12% *
Group 3 (G3)	↓↓ 10% *	↓↓ 15% *	↑↑ 37% *	↓↓ 42% *
Group 4 (G4)	↓↓ 2% *	↓↓ 7% *	↑↑ 6% *	↓↓ 7% *
Group 5 (G5)	↓↓ 7%*	↓↓ 13% *	↑↑ 22% *	↓↓ 30% *

TC: Total Cholesterol, TG: Triglyceride, HDL: High Density lipoprotein, LDL: low Density Lipoprotein. Control group (G1): group took normal animal food.

Apple 3% group (G2): group fed 3gr. apple vinegar in each 100 gr. animal food.

Apple 6% group (G3): group fed 6gr. apple vinegar in each 100 gr. animal food.

Grape 3% group (G4): group fed 3gr. grape vinegar in each 100 gr. animal food.

Grape 6% group (G5): group fed 6gr. grape vinegar in each 100 gr. animal food

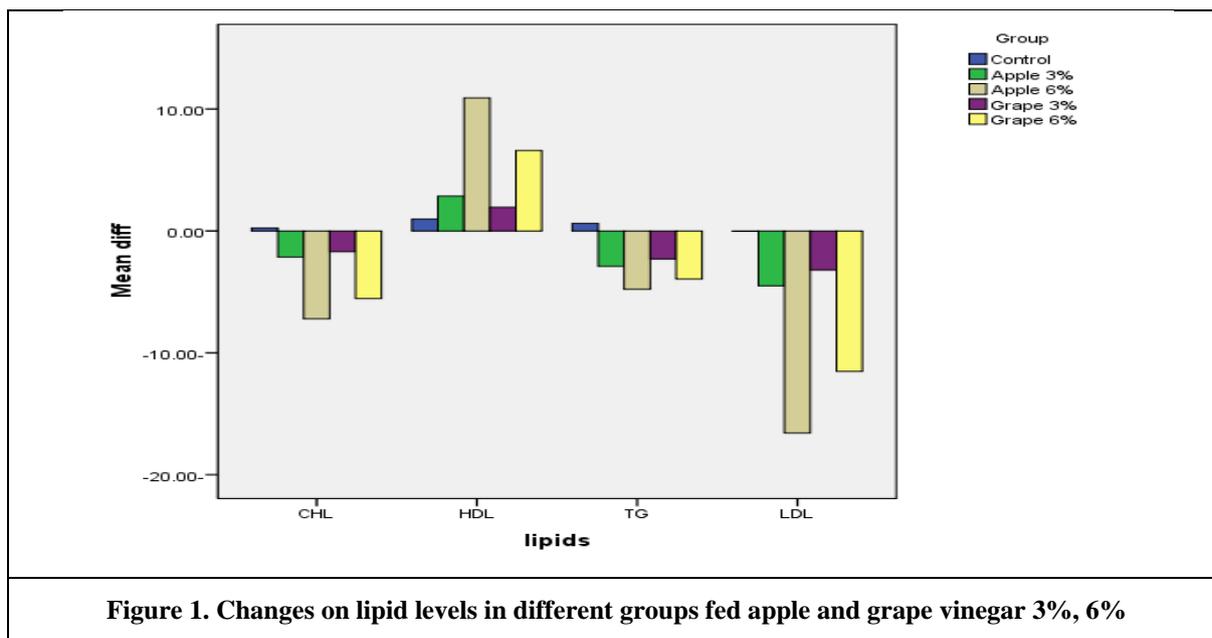


Figure 1. Changes on lipid levels in different groups fed apple and grape vinegar 3%, 6%

4. Discussion

4.1. General aspects

The present study investigated the effect of apple and grape vinegar ingestion (3%, 6%) for four weeks on the lipid profile that including total cholesterol, triglyceride, HDL-cholesterol, and LDL- cholesterol in male white albino rats. Our study showed variable degrees of significant changes in lipid profile levels produced by grape and apple vinegars, being in agreement with a very few studies compared the effect of apple and grape vinegars on lipid profile.

4.2. Effect of apple and grape vinegar feeding on total cholesterol level

The results of this study showed non-significant change on the total cholesterol level after four weeks of feeding standard animal food (control group). Reduction in total cholesterol level was significant in groups fed 6g/100g animal food of apple or grape vinegar. Although acetic acid concentration in grape vinegar (4.2%) is higher than in apple vinegar (3.8%), the apple vinegar showed higher effect in cholesterol reduction, these results might be due to other compounds found in apple

vinegar as polyphenols which plays an important role in cholesterol reduction according to studies performed by Kahle K¹¹, that investigated the effect of polyphenol contents in apple vinegar and its lipid lowering effect. However, the hypolipidemic effect of vinegar was referred to its acetic acid content by a study performed by Kondo et al. 2009, where it suppressed the accumulation of body fat and liver lipids by up regulation of genes for fatty-acid-oxidation- related proteins.

4.3 Effect of apple and grape vinegar feeding on triglyceride level

Feeding 3 or 6 g of either apple or grape vinegar per 100 g animal food has caused significant reduction in triglyceride level. A study conducted in 2012 examined the apple cider vinegar (ACV) effect on lipids in mice with feeding basal mice diet to the control group and the supplementation with either cholesterol (Ch) or sunflower oil (SFO). All groups were supplied drinking water containing ACV (50mg/1). The feeding and drinking was continued for 21 days. Results indicated that ACV decreased plasma total cholesterol and triglyceride markedly ($P < 0.05$), but only in the group which consumed the basal diet (Control + ACV)¹³.

4.4 Effect of apple and grape vinegar feeding on HDL-cholesterol level

Apple and grape vinegar elevated the HDL-cholesterol level in agreement with a study performed by Hansen AS. et al. 2005, where the effect of red wine, one of grape products, showed positive effect on HDL-cholesterol and fibrinogen after consumption for 4 weeks in male human subjects¹⁴.

Shishehbor F. (2007), divided wister rats to 4 groups (the healthy control, healthy fed with white vinegar, diabetic control, and diabetic fed with white vinegar, groups), the control group received standard food and the treatment groups received white vinegar-mixed pelleted food (6% wt/wt) for 4 weeks. Rats in the healthy group fed white vinegar had a significant decrease in LDL-cholesterol (LDL-C) and a significant increase in HDL-cholesterol (HDL-C). White vinegar reduced TG/LDL-C and HDL-C/LDL-C ratios in healthy rats, 44.5% and 25.8%, respectively¹⁵. These results agreed with the results of our study.

4.5 Effect of apple and grape vinegar feeding on LDL-cholesterol level

Significant reduction in the LDL-cholesterol level with apple vinegar may be due to its polyphenol compounds¹⁶ and it combined with elevation in HDL-cholesterol level according to a study by Osada¹⁷. Significant reduction in LDL-cholesterol level was seen in the 3% apple or grape vinegar fed groups and was more prominent in 6% apple or grape vinegar fed group.

In summary, the most prominent effect on lipid profile was seen in the 6% apple vinegar fed group (G3), where 6% grape or 3% apple vinegar feeding (G5, G2), respectively produced moderate improvement, and the grape vinegar 3% feeding (G4) produced the least effect on lipid profile.

5. Conclusion

The most marked effect of vinegar feeding on lipid profile in rats was observed with apple vinegar 6%, and the least effect was with grape vinegar 3%. These changes in lipid profile when applicable might be very beneficial in reducing the risk of cardiovascular diseases and atherosclerosis. Although acetic acid concentration in grape vinegar (4.2%) is higher than in apple vinegar (3.8%), the apple vinegar showed higher effect in cholesterol reduction. We speculate that these results might be due to other compounds found in apple vinegar as polyphenols which plays an important role in cholesterol reduction.

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Conflict of interest

There is no conflict of interest.

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دراسة مقارنة بين تأثير خل التفاح وخل العنب على مستويات الدهون بالدم في الفئران

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ملخص

تهدف هذه الدراسة لتحديد ومقارنة تأثير كل من خل التفاح والعنب على مستويات الدهون في الفئران المخبرية من نوع الألبينو. تم تقسيم 50 فأر إلى خمسة مجموعات بحيث كل مجموعة شملت 10 فئران.

المجموعة القياسية تغذت على غذاء حيوانات قياسي، والمجموعتان الثانية والثالثة تحتوي كل منها على 10 فئران، حيث تغذت على كميات مختلفة من خل التفاح لمدة 4 أسابيع (3%، 6% بالترتيب)، بينما المجموعتين الرابعة والخامسة والتي تحتوي كل منها على 10 فئران تغذت على كميات مختلفة من خل العنب لمدة 4 أسابيع (3%، 6% بالترتيب). تم جمع عينات دم من الفئران عند بداية التجربة وعند الانتهاء لتحديد التغير في مستويات الكوليسترول الكلي، والدهون الثلاثية، والكوليسترول عالي الكثافة، والكوليسترول منخفض الكثافة. أظهرت النتائج نقصاً نو دلالة إحصائية مؤثرة في مستويات الكوليسترول الكلي والدهون الثلاثية والكوليسترول منخفض الكثافة بعد 4 أسابيع من تغذية الخل وصاحبها زيادة في الكوليسترول عالي الكثافة. بالإجمال تبين أن الخل له تأثير مفيد في الحد من أمراض القلب والأوعية الدموية.

الكلمات الدالة: خل التفاح، خل العنب، مستويات الدهون، فئران الألبينو المخبرية.

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